Reference Configuration Overview

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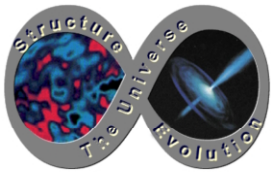
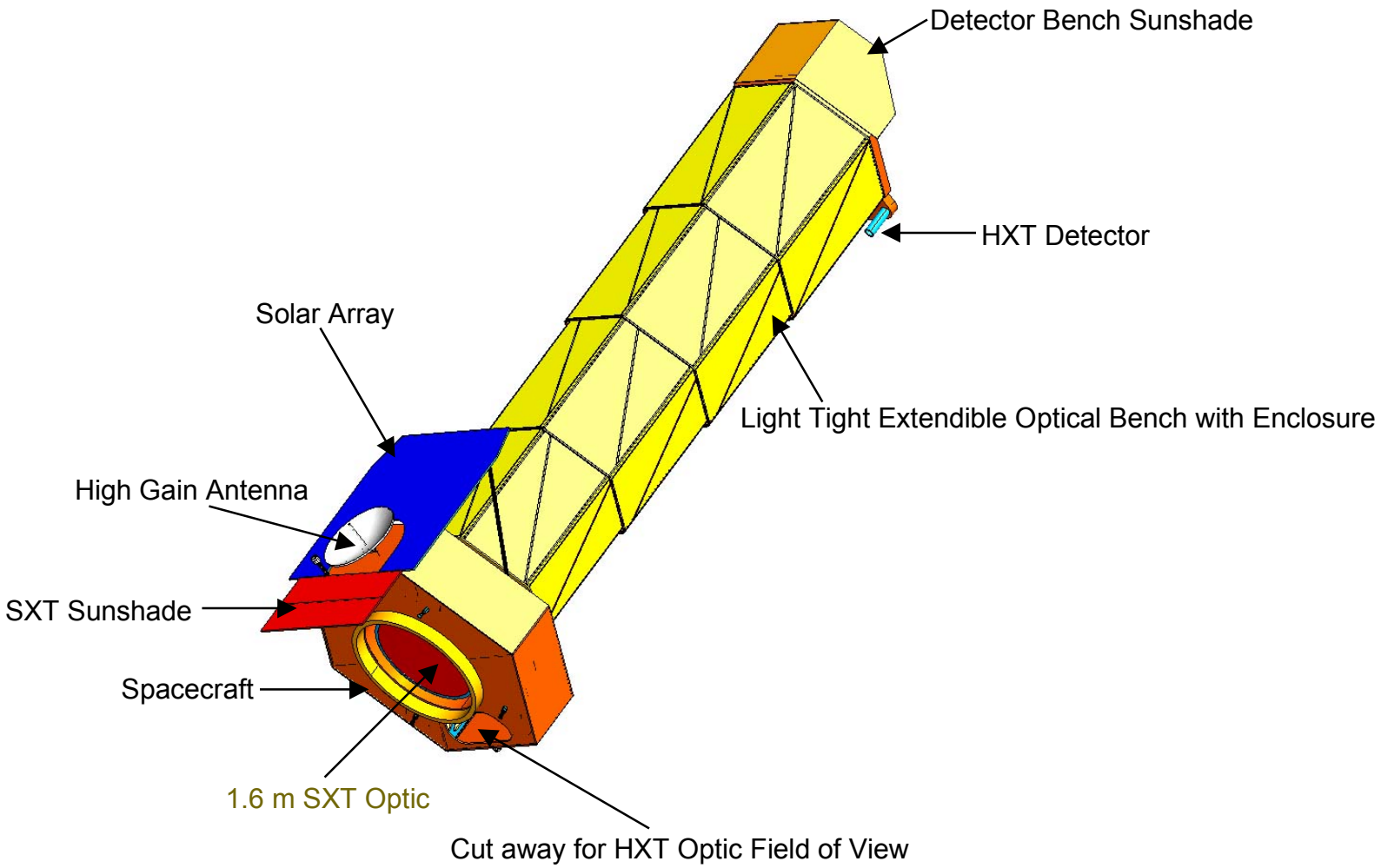


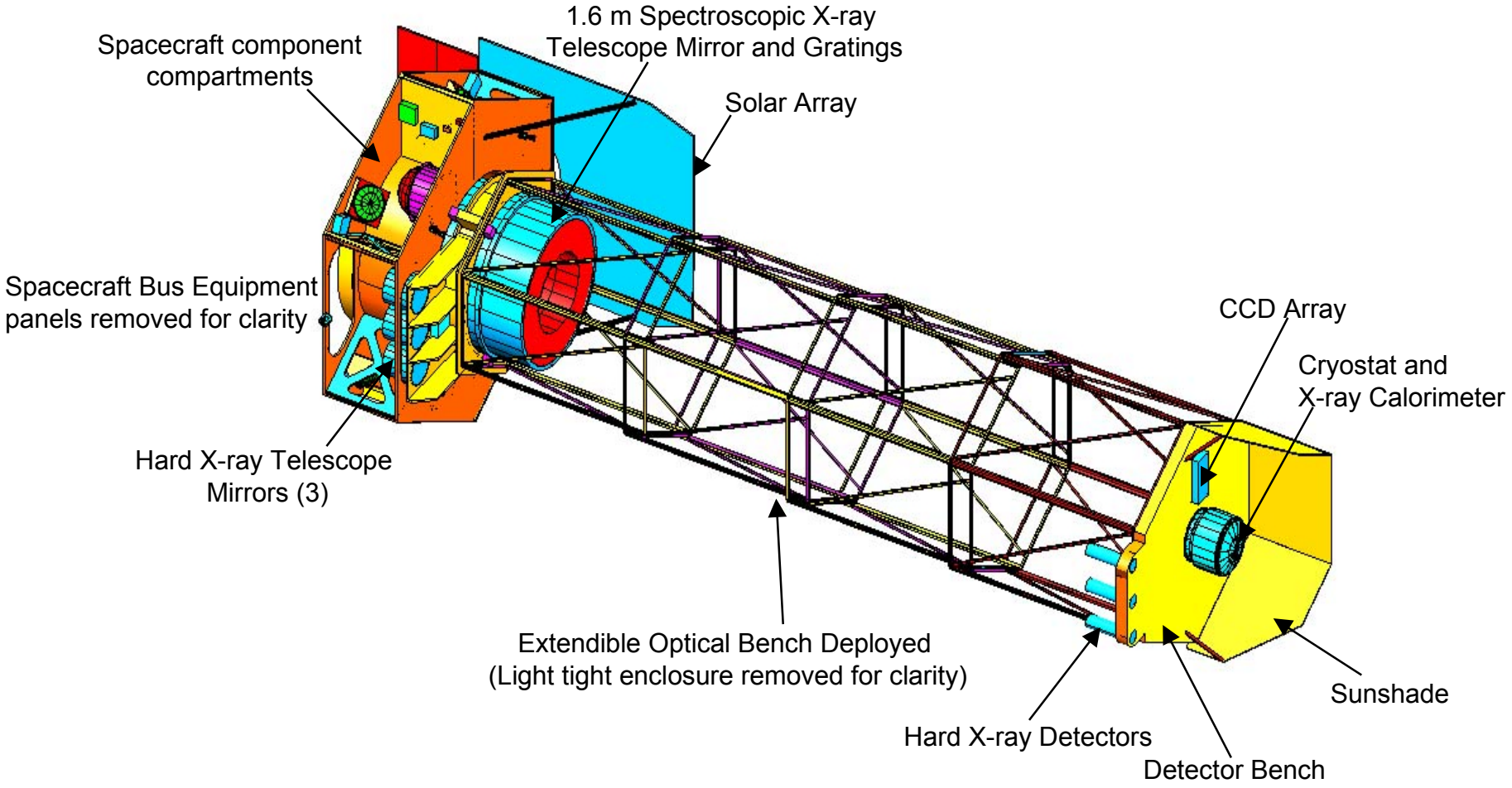
Introduction

- **Reference configuration developed for demonstration of feasibility, establishment of technology requirements and development of cost estimates**
- **Four satellites in mission; launched two at a time on an Atlas V or Delta IV**
- **Each satellite has:**
  - One Spectroscopy X-ray Telescope (SXT) with a 1.6 meter optic
  - Three Hard X-ray Telescopes (HXT) with 0.4 meter optics
  - One Extendible Optical Bench provides 10.0 meter focal length for SXT and HXT and retracts to accommodate dual launch
  - One Calorimeter Detector Assembly at SXT focus cooled by Turbo-Brayton Cryo Cooler with ADR to 50 mK
  - One Gratings Assembly, aft of SXT Optic, disperses x-rays onto an array of eight CCD's located on Rowland Circle
  - One CdZnTe Detector Assembly for each HXT
  - Separable spacecraft bus and instrument modules

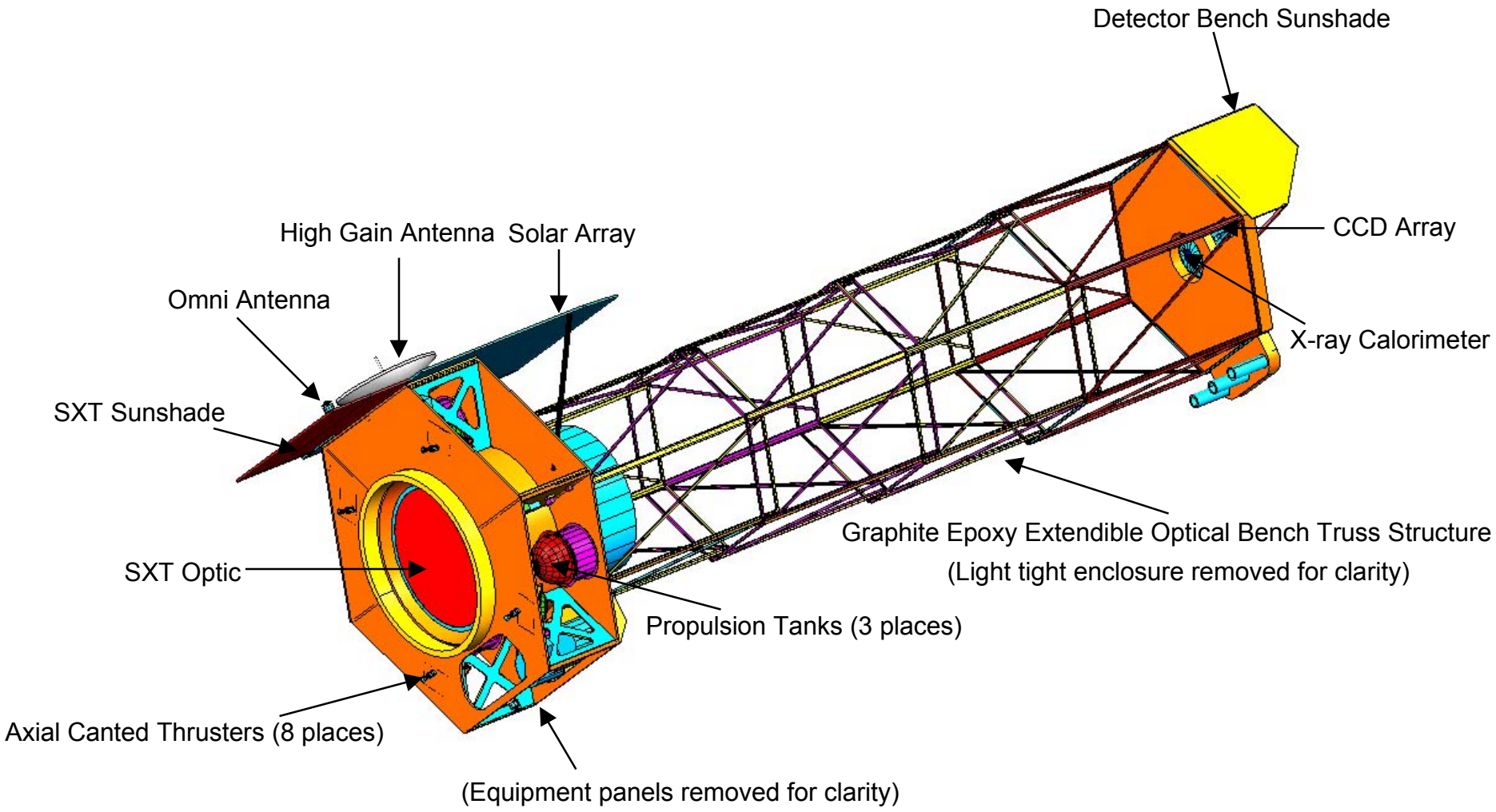
Reference Configuration



Reference Configuration
View from Detector End



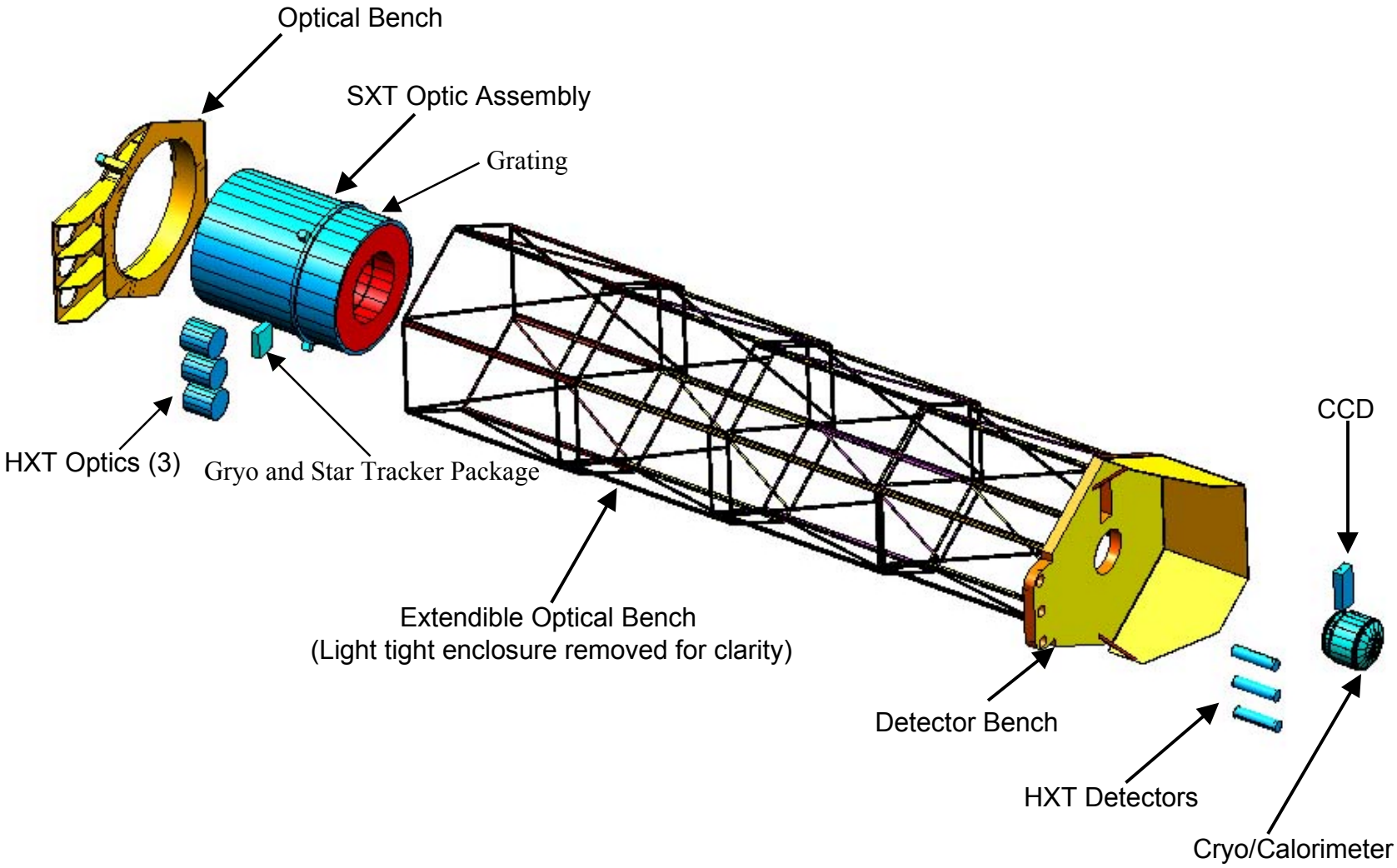
Reference Configuration
View from Optics End



Instrument Module Features

- **The Optical Assembly and the Detector Assembly are configured respectively at warm and cold ends of the satellite for thermal compatibility**
- **Extendible Optical Bench**
  - Constructed from low Coefficient of Thermal Expansion (CTE) composite metering trusses
  - Provides deployable optics with a focal length of 10.0 meters
- **Kinematic mounts are provided to allow stress free deployment and thermal expansion**
- **Cooling for X-ray Calorimeter**
  - Adiabatic Demagnetizing Refrigerator (ADR) provides cooling power of 10 micro watts of 50 mK to detector
  - Turbo-Brayton Cooler provides cooling power of 5 to 100 milli watts at 6 to 10 K to ADR
  - The Detector and Cryo-Subsystem are enclosed in a dewar for thermal isolation from the spacecraft environment

Exploded View (Top/Side) - Instrument Module



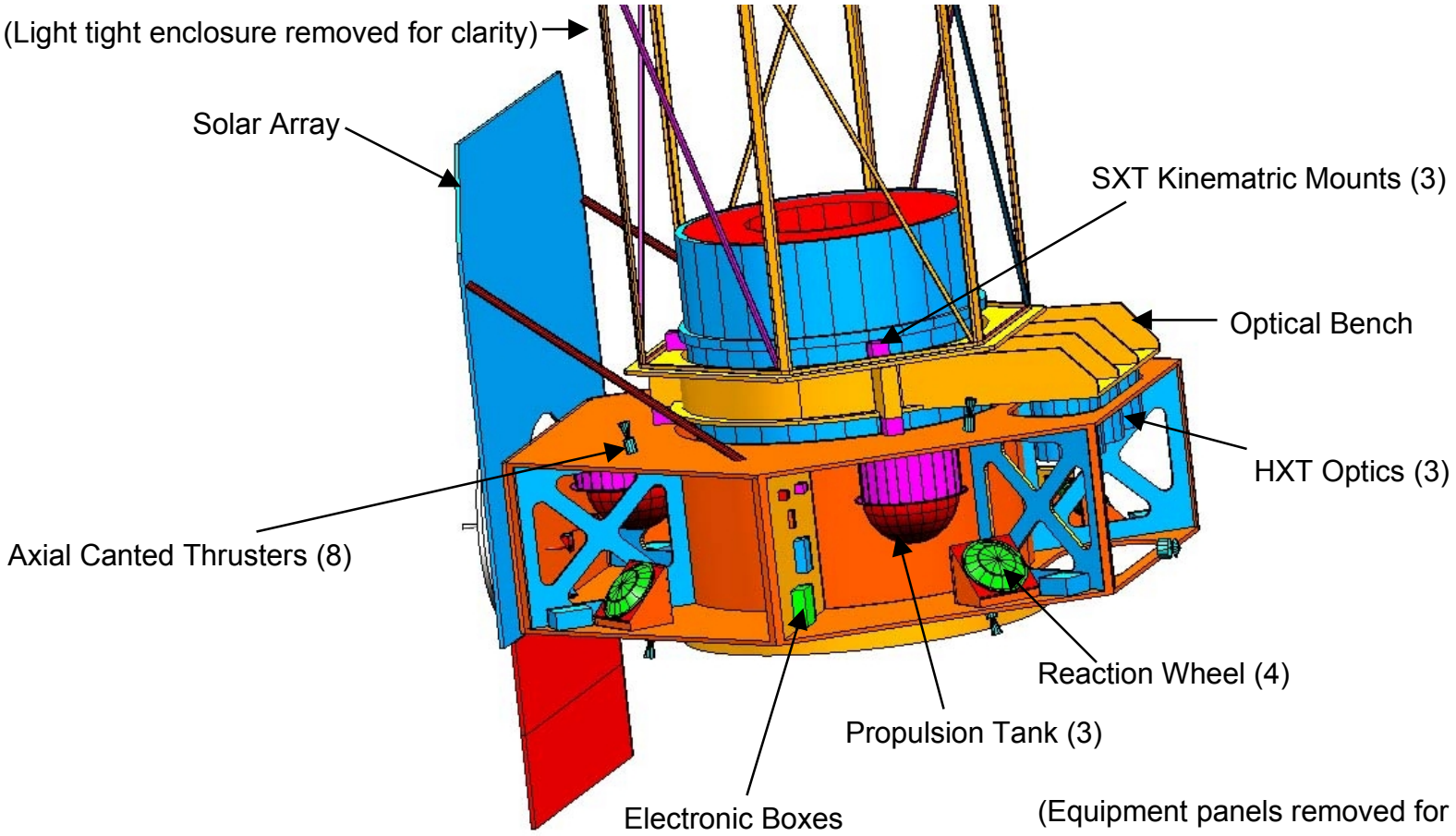
Spacecraft Bus Features

- **Expect use of standard spacecraft bus architecture and components**
  - Showcased in Rapid Spacecraft Development Contract
- **Communication Subsystem**
  - S-Band Transponder, Amplifier and Omni Antenna for Commands and Housekeeping Telemetry
  - X-Band Transmitter and pointed High Gain Antenna for science data dumps
- **Command and Data Handling Subsystem**
  - Performs command handling and telemetry collection functions
  - Synchronizes and provides the Universal Coordinated Time to accuracy of ± TBD seconds to the instruments
  - Stores approximately 10 Gbits of data (2 days) on board the computer
- **Attitude Control Subsystem**
  - 3-Axis stabilized inertial pointing with star tracker and inertial reference units as sensors and reaction wheels as actuators
  - Momentum dumping uses propulsion subsystem
  - Pointing stability ≤1.2 arc sec per 2 seconds in pitch and yaw

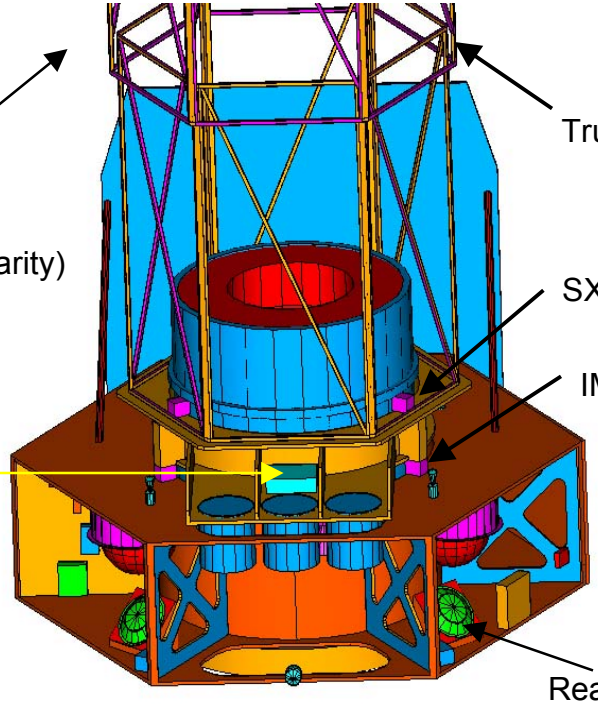
Spacecraft Bus Features (cont.)

- **Attitude Control Subsystem (Cont.)**
  - Pointing jitter ≤ 2 arc sec in pitch and yaw
  - Pointing jitter ≤ 5 arc sec in roll
  - Slew time between targets: 1 hour max.
  - Roll and pitch pointing range of ± 20 degrees max. from normal to sunline
- **Propulsion subsystem uses mono-propellant hydrazine in blow down mode**
  - Eight canted thrusters for fuel efficiency with a specific impulse of 220 sec
  - Three propulsion tanks store 180 Kgs of propellant load to deliver 177m/s of ΔV
- **Electrical Power Subsystem**
  - Ga As Solar Array has End of Life load capability of 1100 Watts
  - NiH battery has maximum storage capacity of 20 AH
  - Power Supply Electronics provides 24 to 34 V of bus voltage

Reference Configuration
View of Spacecraft Bus Components



Reference Configuration View of Spacecraft Bus Components and HXT Optics



(Light tight enclosure removed for clarity)

Truss to Truss Kinematic Mounts (Not shown) typical at each I/F

SXT Kinematic Mounts

IM Kinematic Mounts

Gyro and Star Tracker Package

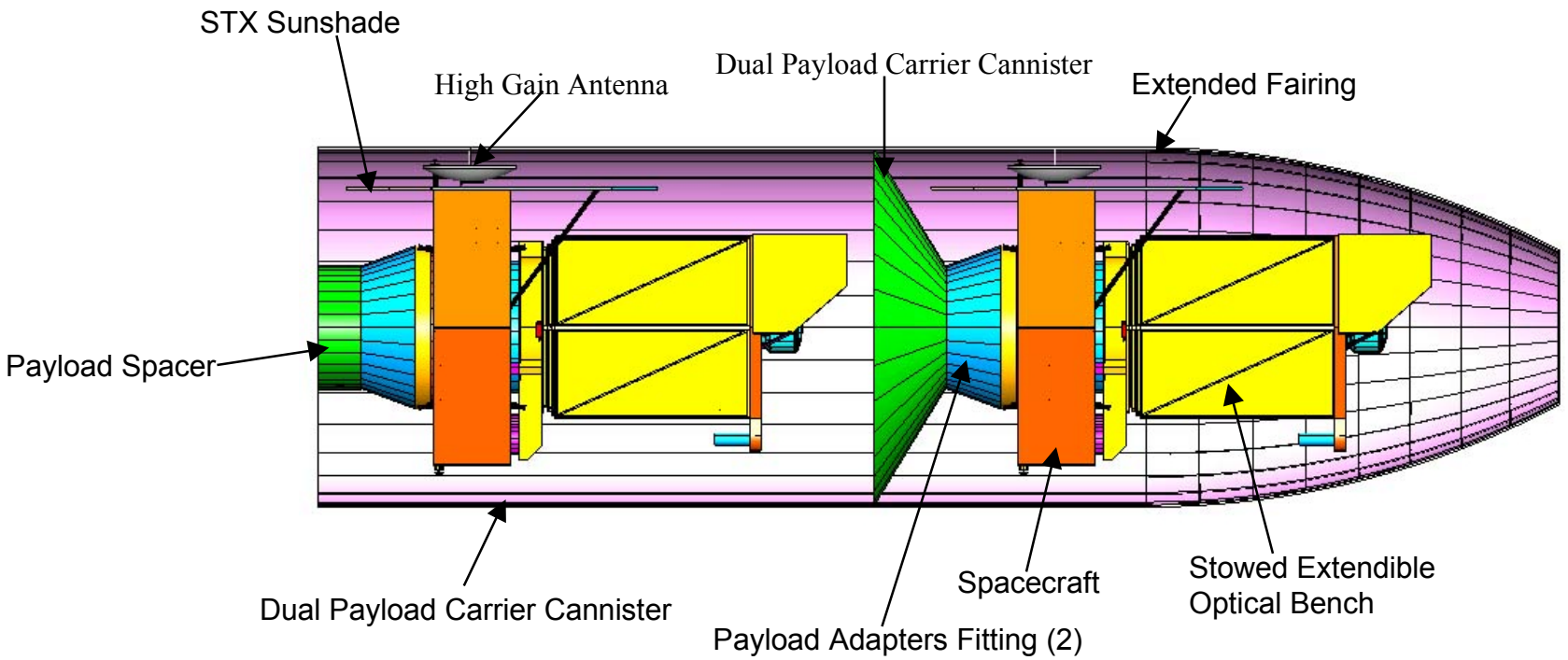
Reaction Wheel (4)

Launch Vehicle and Orbit

- **Atlas V-551 to insert two Constellation-X satellites into the lunar swingby orbit**
  - 5 meter diameter, 87 feet long extended payload fairing
  - 5 solid strap on Booster Rockets
  - 1 heavy common core booster rocket and RD-180 engine
  - Estimated insertion capability of 6500 Kgs. at C3=-2.6
  - Available in December 2002

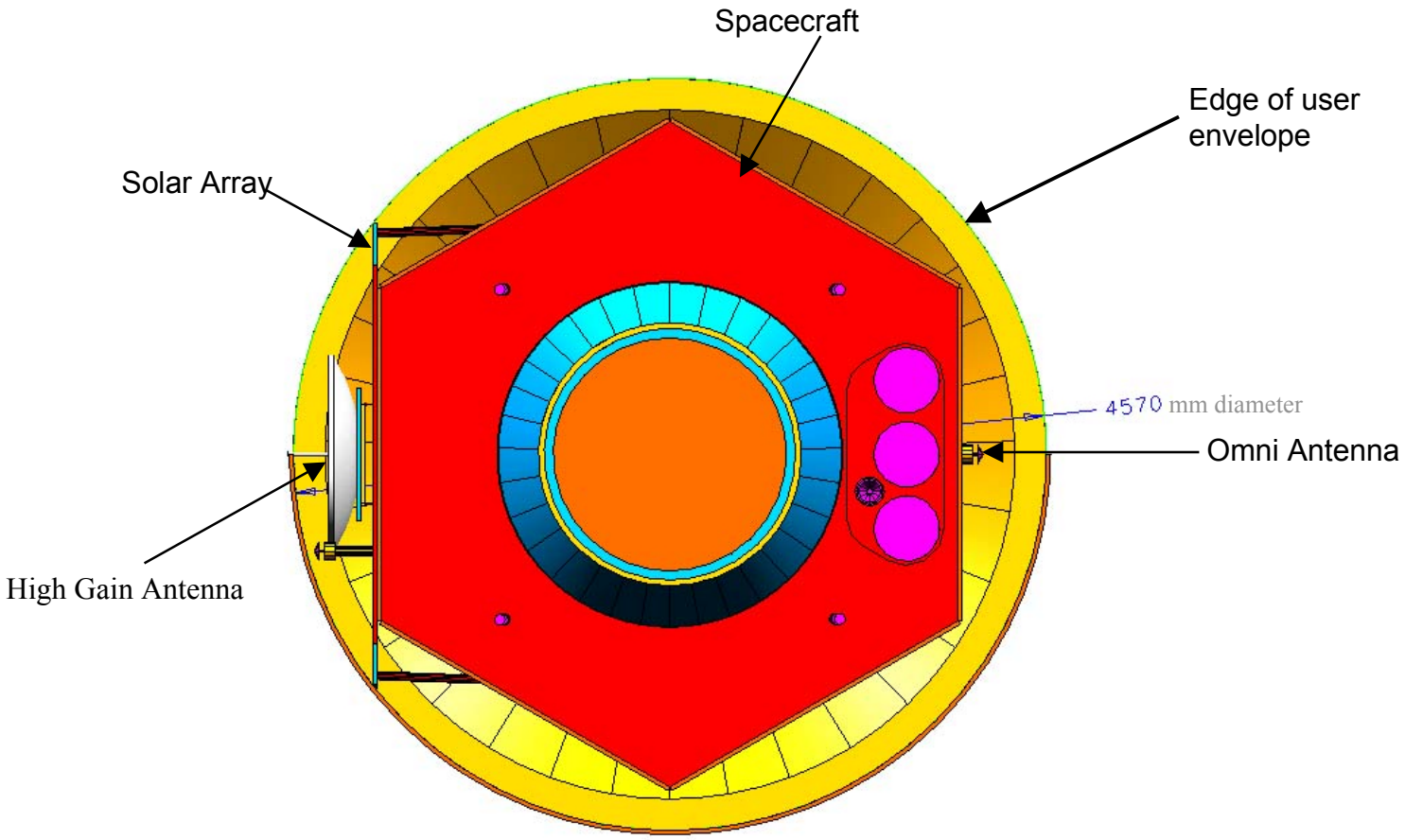
- **Satellite propulsion system used to attain L2 halo orbit**

Launch Configuration



Atlas V Dual Manifest Launch Configuration - Side View

Launch Configuration (cont.)



Atlas V DM Launch Configuration - Bottom View

Resource Summaries

- **Mass Estimate**

Item	Satellite Mass (Kg)	Launch Mass (Kg)
Instrument Module	1459	2918
Wet Spacecraft Bus	761	1522
Dual Manifest Hardware	1500	1500
Margin		560
Total Launch Mass		6500
Estimated Atlas V-551 Launch Capability C3=-2.6		6500 Kgs

- **Power Estimate Per Satellite**

Average Satellite Power Requirement	814 Watts
End of Life Power Capability	1100 Watts

- **Telemetry Estimate per Satellite**

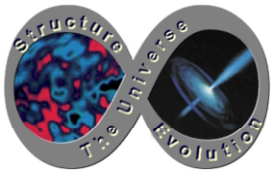
S-Band Telemetry (Housekeeping Data)	2 Kbps
X-Band Telemetry (Science Data)	1.7 Mbps
Telemetry Down Link Time Approximately	1 hour/day

Mass Estimate of Instrument Module

Item	Mass (Kg)
Mirror 1.6 m	750
Grating CCD	48
HXT Optics 0.4 m	165
HXT Detectors	81
Calorimeter	33
Cryo System	90
EOB	292
TOTAL	1459

Mass Estimate of Spacecraft Bus

Item	Mass (Kg)
Structure	175
Mechanisms	7
Power	109
Thermal	17
Propulsion Hrdwr	35
Attitude Cntr Hrdwr	73
C&DH	7
Communications	38
Integration Mtrls	120
Propellent, etc.	180
TOTAL	761



Documentation and Future Plans

- **Reference Mission Description Document**
  - Completed and being reviewed in Project Office and will be available on Web for information and discussions

- **Ongoing work and Future Plans**
  - Thermal analyses of reference configuration is in progress
    - Verifies performance of thermal systems for SXT Mirror Assembly, Gratings, Optical Bench and Detector Bench
  - Structural analyses of the Instrument Module is Initiated.
    - On-orbit requirements of adjustment/alignment mechanisms will be evaluated
  - Evaluate flow down and impact of top level requirements
    - Universal Coordinated Time(UTC) requirements
    - Initiate assessment of accommodation of extended fairing on medium class vehicle with launch vehicle provider